VOLUME XXIV NUMBER 9 WHOLE NUMBER 198

THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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PUBLISHED MONTHLY
(*Ten numbers per year*)

November, 1930

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

THE JOURNAL

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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XXIV, No. 9 NOVEMBER, 1930 WHOLE No. 198

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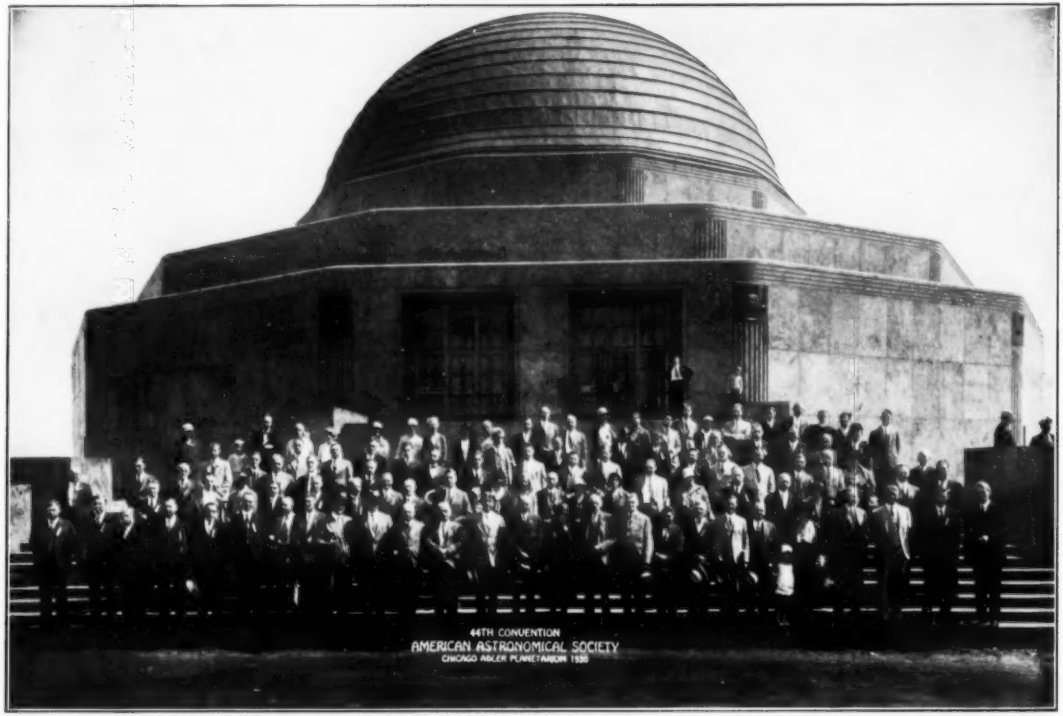
PLATE XXIV



THE AMERICAN ASTRONOMICAL SOCIETY.

44th Meeting, Chicago, Ill., September 3-5, 1930.

Journal of the Royal Astronomical Society of Canada, 1930.

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4. Pawling
5. Lyons
6. G. L. Harrell
7. Snow
8. Miss E. Young
9. J. H. Darling
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11. Andrews
12. Lundin
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16. Pettit
17. C. Schalen
18. Frederick
19. Watts
20. Mrs. Pettit
21. Bert
22. Yowell
23. Eichelberger
24. H. R. Morgan
25. Petrie
26. Helen Pettit
27. Gingrich
28. Harper.
29. R. M. Stewart
30. Miss Barney
31. A. L. Bennett
32. Van Arnam
33. Kingston
34. Albrecht
35. Miss Anne Young
36. Markowitz
37. Littell
38. J. A. Miller
39. Miss Bigelow
40. Nassau
41. Miss Losh
42. Moffitt
43. Curtis
44. Mrs. Roberts
45. Dawson
46. Laurence Dawson
47. Kuehne
48. Mrs. Dawson
49. Fox
51. Menzel
52. Genevieve Dawson
53. Dugan
54. Sullivan
55. Stearns
56. Chant
57. Fecker
58. McLaughlin
59. Mrs. Chant
60. Miss Cannon
61. Miss Bennot
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63. E. W. Brown
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94. Mrs. Boss
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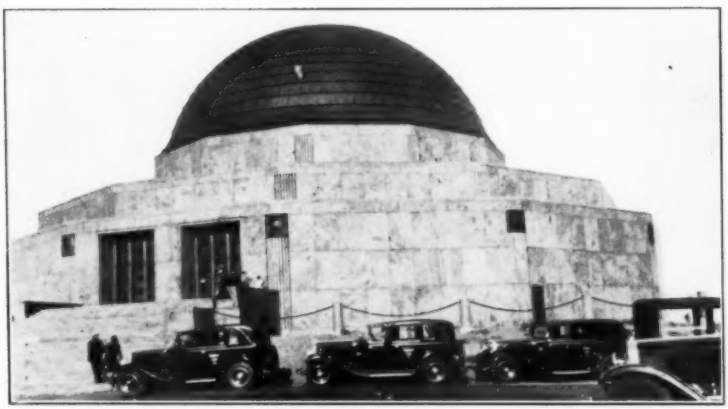

On the Water-front at Chicago

Above—The Shedd Aquarium.
Below—The Adler Planetarium

PLATE XXVI

AT THE MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

Left—A Canadian Group: (from left) Harper, Chant, Petrie, Kingston, Stewart, Campbell.
Right—Two distinguished American women astronomers: Miss Cannon (left) and Miss Furness.

Journal of the Royal Astronomical Society of Canada, 1930.

PHOTOGRAPH OF A RAINBOW, OCTOBER 26, 1929, 8.45 A.M.

Sent by Director L. Rodes, S. J., of the Observatory of the Ebro, Tortosa, Spain. Note the bank of stratus along the mountain chain, the bits of fracto nimbus driven by the wind, the rainbow indicative of the mist bounded by the slope of the mountain.

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THE FORTY-FOURTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

With Plates XXIV-XXVI

By W. E. HARPER

The forty-fourth meeting of the American Astronomical Society was held at the Adler Planetarium and Astronomical Museum, Chicago, Ill., from September 3 to 6, 1930. The Planetarium had only been opened a little over three months and it was exceedingly kind of Director Philip Fox to afford the members of the Society such an early opportunity of looking over this newest instrument for popularizing astronomy.

It was with something of a feeling of nervousness that the writer from the quiet, peaceful little city of Victoria entered the great metropolis by night,—the city which has such a reputation for hold-ups and organized crime. However, he got safely from the station to the Stevens Hotel, the headquarters of the society, and breathed easier when next day he pinned on his badge, for gangsters would rightly guess that an astronomer is not worth robbing. While the better class of citizens feel keenly the stigma attached to their city for its civic misgovernment and gangster rule, yet it is possible that in this latter aspect it has been over-maligned. As the negro porter on our train put it as we were passing through a city in North Dakota: "There were five murders here recently in as many weeks and if this had happened in Chicago why their own papers would have published it in flaming headlines." This much may be said,—that the writer was never molested, and enjoyed his few days' stay at the Stevens Hotel—the largest in the world—to

Journal of the Royal Astronomical Society of Canada, 1930
bounded by the slope of the mountain.

the utmost, and carried away most pleasant memories of his brief visit. The illumination of the fountains and the tall buildings along Michigan avenue by night is a wonderful spectacle and one not easily forgotten.

Chicago is in the midst of great preparations for her 1933 Exposition, creating an island on the lake front on which will be placed the main buildings for the exposition. The Adler Planetarium is the first one of these buildings to be erected and is the gift largely of a wealthy Chicagoan, Max Adler, who gave half a million for this purpose. The main administration building of the exposition is also now in course of construction. Nearby are the Shedd Aquarium, where almost every conceivable kind of fish may be seen and studied, and the Field Museum of Natural History and Art, where one could spend several days in examining the specimens in the various divisions. Here was seen the large meteorite, weighing 820 pounds, that was actually seen to fall near Paragould, Kansas, on February 16, 1930.

The Planetarium seems to call for a fuller description. This is the first one on the American continent though very shortly Philadelphia is to be favoured. It is about six years ago since the first ones were established at Munich and Jena. Briefly put, they are hemispherical domes, 50 to 70 feet in diameter, on the inner side of which the stars are represented just as they appear in the sky. This is accomplished by means of numerous projectors each showing a small portion of the sky and all unified in the so-called planetarium instrument, which occupies the centre of the room and whose motions can be controlled by the lecturer. The great circles like the equator, the ecliptic and the prime meridian, marked in degrees, can be thrown on or off at will by means of auxiliary projectors. Other projectors again show the planets and each and all have the proper gear ratios so that when once set correctly in the heavens they will never get out of their correct positions among the stars for ages to come.

By rotating the instrument, the diurnal motion of the sun by day and the stars by night can be faithfully portrayed. You see well-known stars rising in the east, mounting higher in the heavens and eventually setting in the west. The moon and planets also pursue their prescribed paths, and by speeding up the mechanism

the retrograde motion of the planets becomes very evident. Professor Fox, who gave the demonstration on the first evening to the members of the society and a number of other invited guests, took us on an imaginary trip to southern lands and we saw the heavens as do those living in southern latitudes. Moreover, by speeding up the mechanism we were projected into the future when, owing to the precession of the equinoxes, Vega, not Polaris, becomes the Pole Star. At the commencement of the demonstration the lights were gradually dimmed and as twilight deepened into darkness, to the accompaniment of low music, the stars came into view. Similarly, at the close the dawn came on, the fainter stars were lost to view and eventually daybreak was at hand. The writer went expecting a thrill and certainly had one.

Surrounding the planetarium auditorium which, as may be inferred, is circular in shape, is the Astronomical Museum. The auditorium is 68 feet in diameter and surrounding it is a hall 30 feet or more in width, which is the Astronomical Museum proper. On the walls, illuminated from behind, are excellent reproductions of the sun, moon, planets, comets and spectra of various types of stars. In cases set into the walls are collections of old astronomical instruments, such as armillary spheres dating from the year 1500, sun dials of every conceivable form, with sextants and old sea glasses. Models of some of the observatories are on view, especially good being that of the U.S. Naval Observatory with its 26-inch telescope. With a press on the button the visitor can see how domes revolve, the telescopes move into position and the floors are made to rise or fall as may be required. Present day work of the great makers of telescopes are also to be seen, in many cases these being donated by the makers or their friends. During the meetings the Royal Astronomical Society's Gold Medal to Burnham was deposited in the museum, so the varied nature of the collection which Fox is gradually acquiring may be inferred.

Before mention is made of the papers presented at the meeting, reference might be made to a luncheon given by the Woman's Club of Chicago in their splendid new club building to do honour to two outstanding women astronomers who were present. The writer was one of about a dozen men who were invited to the luncheon to form, I suppose, a "fringe" on the gathering. Miss Cannon, as the

chief woman astronomer of the world, in acknowledging the kindness of the Woman's Club, spoke briefly of her recent trip to Iceland on the occasion of the 1000th anniversary of the founding of the Icelandic Parliament. Miss Furness, head of Vassar Observatory, also spoke briefly of her experiences in the teaching of astronomy.

Thirty-one papers appeared on the printed programme which had been mailed to members previous to the meeting. Nine more appeared on a supplementary sheet, while a few others in addition were presented. It seems best to summarize these, not in the order as printed nor as presented, but rather under three headings: I Solar System, II Stellar System, and III Miscellaneous. All but three, I think, were actually read at the meeting.

I. Solar System

Abbot reported on the progress being made in the prediction of weather changes over longer periods than is now possible through a study of the variations in the solar constant. Short period changes of the order of four or five days and amounting to one-half per cent. have been studied at three stations, Washington, D.C., Dakota, and California. From the Washington records an increase of three-quarters per cent. in the solar constant is found to cause a temperature increase of 5°. The other stations seem to corroborate this result.

Pettit outlined his results to date with his silver-gold device for measuring the ultra-violet solar radiation. The deflections of a galvanometer caused by the radiations through these two screens at $\lambda 3200$ and $\lambda 5000$, respectively, are automatically registered at short intervals on a moving plate. Close correspondence exists between the ultra-violet radiations and the number of sun-spot groups.

Three papers dealt with the central eclipse of April 28th last in California. The moving pictures were rather disappointing as cloudy weather interfered. It appeared also that focussing on the curved dome of the planetarium is not the most successful way to project slides. Pettit's coronal pictures were, however, of much interest. His time from the movietone film showed eclipse had occurred 1 7/8 seconds earlier than predicted, but Brown considered a probable error of one second to be expected.

Peters and Wagman, of the Naval Observatory, showed the sun-spot curve of recent months to be similar to others presented. Minimum will occur in 1934, but a secondary maximum is due in 1931.

Menzel has been studying the sun's chromosphere from eclipse plates made at the Lick Observatory, particularly those of 1905. While these lack modern sensitometer strips for comparison, some useful results have been secured. Contrary to expectation, the contours of the high level lines are flatter than those of the low level lines. Some relation between the heights and the voltages corresponding to the lines seems to have been established.

Menzel has developed a theory of the chromosphere which treats it as simply a form of turbulence. He looks upon turbulence and not pulsation as the cause of Cepheid variation. One member called his attention to DeLury's paper in this JOURNAL of many years ago along the same line. Fox considered that the prominences were distinctly in a different class.

Bobrovnikoff has made a chronological study of 271 photographs and 77 spectra of Halley's Comet of 1910, assembled by Curtis and on file at the Lick Observatory. The rapid changes in the streamers ejected from the nucleus, which would be impossible to follow on photographs from any one station can, from this collection, be followed without any uncertainty or ambiguity. Impulses apparently change one streamer orbit into another with great rapidity, of which illustrations were shown.

Wylie discussed the paths over the central States of recent meteors, instancing the Amana group of meteorites which fell in an oval-shaped area seven miles long by three miles wide. Wylie, it was brought out in the discussion, was the one chiefly instrumental in securing the splendid specimen in the Field Museum previously referred to. He made a plea for two stations well equipped for the observation of meteors.

II. STELLAR SYSTEM

In the realm of positional astronomy some short papers of interest were presented. Systematic differences of the order of 0″.015 between two observers at the Naval Observatory were due, in Littell's opinion, to the manner in which they cleaned the surface of the mercury basin used in the photographic zenith telescope.

Results were presented by Watts of the flexure determinations made by himself and others by the Bornsdorff method.

The positions of the 409 stars selected by Kopff as standard stars for the Eros campaign have been observed four times by Hammond with the six-inch meridian instrument at the Naval Observatory.

Brouwer at Yale in his observations on the annual or fourteen-months' term in the moon's longitude, finds less systematic error for the faint stars than for the brighter ones, no explanation of which could be given by Brown, who read the paper.

Lee discussed the question of negative parallaxes, plotting the 194 such found in Schlesinger's catalogue with respect to right ascension and finding a marked trough at 13 hours' right ascension, directly at variance with those found in the programme of faint stars from 9.5^m to 11.0^m as carried on by himself. No one seemed to be able to offer any explanation as to a change in the frequency curve for negative parallaxes in the two cases. The Eddington-Dyson disposition of negative parallaxes was favoured by some.

Rufus has done considerable work on the difference in velocity for Cepheids as determined from lines that occur at different levels in the atmosphere. Such has been criticized by Henroteau and Hause, but Rufus submitted his results for *zeta* Geminorum, whose velocity graphs for each class of lines seemed to show the lag in phase for which the author contended.

The star *mu* Cephei, at its recent maximum of 3.8^m, has shown that hydrogen *alpha* is present as emission, slightly (3 km) displaced to the redward side.

Marshall rediscussed the overworked star *rho* Leonis and finds a constant radial velocity in substantial agreement with Harper's and Lee's (revised) results.

The results by Kiess and Mrs. Kiess of their investigation of the spectrum of chromium carried on at the Bureau of Standards has resulted in a number of additional lines in the solar spectrum being ascribed to this element. Appreciation was expressed by Menzel of the helpful character of the work of the Bureau to other workers.

The desire to have the spectral class of stars appearing on the Eros plates led Miss Cannon to classify a total of 1,703 stars. On

the best plates 222 had been re-classified which, when compared with the previous classification, showed an average difference of only 0.2 type division. She finds the interval from G5 to K0 the shortest and hardest to deal with.

Higgs has studied the spectrum of *pi* Aquarii, a B-type star showing hydrogen emission of the *phi* Persei type. In this star not only do the components vary in intensity but sometimes they vanish altogether. Contours and Moll tracings were shown and Curtiss' period of 2,700 days is found to be inadmissible.

By means of objective prism spectra of A-type stars in clusters in which relative apparent magnitudes represent relative absolute magnitudes, Miss Anger has sought relationships between the hydrogen lines and absolute luminosities. No connection of the latter with the line contours or Stark effect are found, but there is a relationship with the total absorptions of the lines.

Mrs. Dorothea Roberts, widow of the late Isaac Roberts, spoke of his early photographic plates and felt that more information of much value could be secured if some process were discovered of bringing out the latent images on the plates.

Following up Trumpler's work, who seemed to find an absorption of light in space equal to 0.67^{m} per 1,000 parsecs, Van de Kamp has secured results on certain regions in Cygnus which seem to corroborate his findings on selective absorption.

Numerous instances of inconsistencies between colour-index and type at Harvard led Schalen to investigate and he also finds evidences of selective absorption.

Schlesinger reported on photographic observations of Eros, and Miss Harwood made an appeal for careful determinations of its brightness over short intervals of time as the variations are not necessarily periodic.

Pearce gave new elements for the rotation of the galaxy from the final velocities of 790 O and B type stars. He finds the longitude of the massive nucleus to be 328° with A, the velocity due to galactic rotation to be .016 km/sec per parsec. Nearby stars do not show it but do show a large K-term; the fainter and distant stars have no K-term but show the galactic rotation very definitely.

Williams has confirmed previous workers that in P Cygni the

widths of the emission lines vary directly as the displacement of the absorption lines.

Harper gave the elements of the orbit of two spectroscopic binaries, Boss 523 and Boss 4876. The former shows a peculiar trend of the residuals but for the present these are considered as accidental.

Interesting photo-electric data were presented by Huffer concerning the stars H.R. 7165, Boss 1607, H.D. 25833, and 44 Boötis. All are found to vary in light, two being eclipsing variables. Both he and McLaughlin showed the light curve of *epsilon* Aurigae during recent months.

III. Miscellaneous

Pictures were shown of the double slide plate holder developed by Moffitt for the Yerkes telescope. A rotating sector reducing two magnitudes can be moved in either coordinate to any star in the field. Efficiency is increased ten per cent.

Boss read a theoretical paper dealing with correlations between astronomical and geophysical phenomena. Much was made of penetratng radiation to explain geophysical problems and had the paper been presented by a "lesser light" than Boss, some parts of it might have been considered fantastic.

Hubble and Duncan presented measures of the disk of Nova Aquilae (1918), which show that it is still increasing in size. The disk is now 22″ or 8,000 astronomical units in diameter.

The foregoing summary of the papers has been prepared from brief notes made at the time without any opportunity of reference to astronomical journals. It is hoped the gist of the papers has been caught and faithfully reported, although in a few cases some uncertainty exists.

One should not close without some reference to the many courtesies extended to the visiting members. In particular the yacht ride on the second afternoon in the palatial launch "Mizpah," owned by Mr. E. F. McDonald, president of the Zenith Radio Corporation, was one feature greatly enjoyed by the members. This vessel is 185 feet in length, carries a crew of 27, is luxuriously furnished and from its decks the members, in their two-and-a-half-hour cruise, got

a splendid view of Chicago's water front and the tall buildings along it.

The writer had considerable work to do in keeping the members of the contingent from Canada safe from the wiles of the great city, but he hopes that after the Society dinner on the last evening and their visit to the Yerkes Observatory, all got safely back to the homeland. Those present from Canada included Mr. and Mrs. R. M. Stewart, Professor and Mrs. C. A. Chant, Mr. and Mrs. C. C. Smith, Dr. and Mrs. J. W. Campbell, Dr. H. R. Kingston, R. M. Petrie, and the scribe.

Owen Sound, Ontario,
Sept. 10, 1930.

A GREAT ASTRONOMER—H. H. TURNER

(From *The Times*, London)

Professor Turner, whose death at the age of sixty-nine is announced on another page, was not only a pioneer in astronomical research, but was also a singularly gifted expositor of the wonders of his science. In him *The Times* loses a valued contributor of long standing.

Herbert Hall Turner, the son of Mr. John Turner, was born at Leeds in 1861, and was educated at Leeds Modern School, Clifton College, and Trinity College, Cambridge. His career at Cambridge was brilliant; he graduated as second wrangler in 1882, and was second Smith's prizeman in the following year. He was elected a fellow of Trinity, but left Cambridge in 1884 to become chief assistant at the Royal Observatory, Greenwich, where he remained until 1893, when he was appointed to succeed Professor Pritchard as Savilian Professor of Astronomy and director of the University Observatory at Oxford.

Turner's contributions to astronomy were remarkable for their number and variety; he published over two hundred papers and essays on scientific subjects. He had a fertile and ingenious mind, and more than the usual amount of courage in putting forward ideas and speculations. Many of his ideas have not met with general acceptance, but this is a fate that must befall some part of the work of any one who has a claim to be called a pioneer. When he assumed the direction of the University Observatory at Oxford, he found it committed to taking a part in the international scheme of mapping the heavens, which had been decided upon at a conference in Paris in 1887, and he threw himself into the work with so much enthusiasm that the Oxford section was finished before that of any other observatory with the exception of Greenwich, the only other observatory in England which was allotted a part on the scheme. He then proceeded to help some of the other observatories which were finding the burden of the work too heavy for them, and when the International Astronomical Union was formed after the war, he was elected president of the committee delegated to deal with the scheme.

Much of the technique of the methods now universally employed for deriving the positions of stars from photographs is due to him, and this is perhaps his greatest contribution to astronomy. He also did a large amount of useful work on the classification of variable stars, and put forward a theory to explain stationary meteor radiants, but his explanation of sunspots as being due to a swarm of meteors formed by collision between the Leonids and the rings of Saturn has not been generally accepted, and the same must be said of his attempt to account for the two star streams in terms of gravitation.

When Professor Milne, the seismologist, died in 1913, Professor Turner took over the control of his seismological bureau at Shide, and on the return a few years later of Mrs. Milne to Japan the bureau was moved to Oxford, where it remained under the direction of Professor Turner as president of the seismological committee of the British Association. He was also president of the seismological section of the International Geophysical Union, and himself did a large amount of work on the analysis of earthquake records, with a view to detecting periodicities in them. His frequent communications to *The Times* on earthquakes he had detected in remote parts of the world will be well remembered, as also his letters and articles on eclipses and other astronomical subjects.

He spared no effort to promote international co-operation in astronomy, and was a well known and popular figure at international conferences, of which he attended a large number. He also went on several eclipse expeditions, including those to Japan in 1896 and to Egypt in 1905, and when the office of foreign secretary of the Royal Astronomical Society fell vacant in 1919, he was clearly marked out for it.

Turner had a great gift for presenting the complicated facts of modern astronomy in a way easily understood by the lay mind, and was an excellent lecturer. He wrote four very readable popular books on astronomy, "Modern Astronomy," "Astronomical Discovery," "The Great Star Map" and "A Voyage in Space," the last being the outcome of a series of children's lectures at the Royal Institution in 1913. For more than thirty years he contributed each month to the periodical, the *Observatory*, a series of notes, light in vein, under the heading "From an Oxford Note Book," which formed a feature of the magazine that has been greatly appreciated

by astronomers all over the world. He was for many years secretary, and then president, of the Royal Astronomical Society Club, where he could always be counted upon for an apt after-dinner speech, and, on occasions of any importance, for a song. He had the all too rare gift of being able to enter into other people's difficulties, and there must be many amateur astronomers, in addition to some of the younger professional astronomers, who will always gratefully remember help and advice given both frequently and ungrudgingly.

As Savilian Professor at Oxford, Turner became a fellow of New College. Coming to the university, he threw himself wholeheartedly into the intimate life of the college, entering with zest into its activities, educational, scientific and social, and contributing a valuable element to its discussions by his independent, yet sympathetic, point of view and a breezy disregard of conventions which now and again shocked more conservative minds.

It was unfortunate that the refusal of the university to provide an official house in the Parks for the Professor of Astronomy made his relations with the university less cordial. This and the remoteness of astronomical studies from the ordinary curriculum rendered his influence in Oxford less than it ought to have been. But those who knew him well were aware of the keen interest which he took in its studies and general welfare, and also in the lives of his friends and colleagues. No one was more ready to give active help to his friends in any time of trouble. It was characteristic of his generous temper and his sympathy with struggling causes that from the first he gave his vigorous support to the Workers' Educational Association and the organization of tutorial classes. In this work his optimism and persistence were invaluable.

Here, as in everything else he took up, his help was direct and personal. He had the courage and strong will of a true Yorkshireman, and he also shared the North Country love of music; he was an assiduous member of the Oxford Bach Choir, and an active supporter of musical enterprises. A lover of the open air, he had a close acquaintance, by bicycling, boating and walking, with the beautiful country near Oxford, and in other parts of England, and his scientific expeditions gave him a wide acquaintance with the oversea dominions and with foreign countries. In these activities he was fortunate

in having a wife who shared in his tastes and in much of his travel. The astronomical world is weaker by his death, and he has certainly left in his college and among his friends in the university a place which cannot be filled.

Professor Turner was elected a fellow of the Royal Society in 1896, and was president of the Royal Astronomical Society in 1903 and 1904. From 1913 to 1922 he was one of the general secretaries of the British Association. He was given the honorary degree of D.Sc. by the Universities of Leeds, Sydney, Wales and Strasbourg, that of D.C.L. by Durham, and that of LL.D. by California. He was also a corresponding member of the French Institute, and he received the Bruce gold medal of the Astronomical Society of the Pacific in 1927.

ALPHA AND PROXIMA CENTAURI

By E. G. Hogg*

Proxima Centauri

We are indebted to the Johannesburg *Star* for the following account of the circumstances which led up to the discovery of our nearest stellar neighbour—Proxima Centauri. It would appear that about 1915, Dr. Innes, Director of the Union Observatory, Johannesburg, being impressed with the increasing number of cases in which a star—single or binary—was found to be attended by one or more faint companions, decided to utilize the services of his observatory to see whether the double-star Alpha Centauri might not be added to the list. He possessed photographs of this region of the sky taken at Johannesburg in 1910; his assistant, Mr. Wood, took in 1915 another photograph of the region with the same telescope, and under the same conditions as the 1910 one. On comparing the two sets of plates, Dr. Innes at once detected a faint star, of photographic magnitude 13.5, which had changed its position relative to the other stars during the interval of five years, and further investigation showed that its motion was nearly equal and parallel to that of Alpha Centauri. The connexion was further established when the parallax of the faint star was found to be almost exactly equal to that of Alpha and thus at approximately the same distance as it from the earth; the name Proxima Centauri was given to our new neighbour.

Recent Work on Proxima

We would premise that by the parallax of a star is meant the angle which would be formed if two straight lines were drawn from the star, one to the sun and the other to the earth, *i.e.*, it is the angle subtended at the star by the line joining the earth to the sun; it is in all cases a very minute quantity and can only be determined by the exercise of the greatest skill and care. Some new measurements

*In "Astronomical Notes" of the New Zealand Astronomical Society.

of the parallaxes of Alpha and Proxima Centauri, made by Dr. Alden at the Yale station at Johannesburg, have recently been published; it appears that the parallaxes of Alpha and Proxima are respectively 0.765 and 0.783 seconds of arc, showing clearly that Proxima is the nearer of the two to the earth, its distance from us being 24.5 billion miles, while that of Alpha is 25.1 billions. The mean distance of Proxima from Alpha is 1.1 billion miles or more than twelve times that which separates the earth from the sun, and its period of revolution about Alpha is about a million years. It is a dwarf red star, with a temperature much below that of the sun; it is estimated that it is a little smaller in size than the planet Saturn.

Alpha Centauri

The binary nature of this star was discovered by the gifted Abbé Lacaille in 1752, at the Cape of Good Hope, whither he had travelled for the purpose of studying the stars of the Southern Hemisphere—a field of work which had not been touched since Halley's visit to St. Helena in 1677-78. A great amount of information about this double star—the most striking in the heavens—has accumulated by now, to which we will briefly refer. The brighter component *A* is very similar to the sun, weighing about 14 per cent. more than that body, and being about 12 per cent. more luminous; the other member *B* is considerably redder than the sun, and its surface temperature is only about 4400 deg. centigrade, against the sun's 6000 deg. centigrade; it has 97 per cent. of the sun's weight, but only about one-third of its luminosity, and its diameter is 22 per cent. greater than that of the sun. The two together form a visual binary whose apparent magnitude is 0.3.

They describe their orbit—an elongated ellipse—in 81.18 years, and we see it nearly edgewise, consequently as they move round it the angular distance between them is continually changing. According to a paper contributed some years ago to the *Astrophysical Journal* by Dr. Lunt, of the Cape Observatory, the two stars were 17 seconds of arc apart in 1919; the distance between them is slowly decreasing at present, and in August, 1937, will be reduced to 4 seconds; after this they will separate out until in 1951 they will be

10 seconds from each other; they will then close up, and in 1959 the angular distance between them will reach its minimum value—just under 2 seconds. The maximum angular distance between them, which is just over 22 seconds, occurred in the middle of 1889, and will be reached again in 1980; on these occasions they are about 850 thousand million miles from each other.

Alpha Centauri is moving across the sky at the rate of about 3.68 seconds of arc per annum, and it also is receding from us at the rate of about 14 miles a second; by combining these movements Mr. C. L. Stearns recently determined the actual motion of Alpha relative to the sun, and he found that it made its nearest approach to the earth about 28,000 years ago, when it was about three-tenths of a magnitude brighter than it is now. It will, however, long remain the most brilliant spectacle of its kind in the heavens; telescopic equipment will doubtless improve vastly in the centuries to come, and we may expect that it will appeal to our far-off descendants as powerfully as it does to us.

THE MOON

A CONCISE SUMMARY OF INTERESTING ITEMS FOR THE AMATEUR

By W. G. Colgrove

Name—Among the Egyptians and Babylonians it was a male divinity. The former called it Aah and Thoth, while the latter named it Nannar and Sin—the light-giver and dispenser of wisdom. The Greeks somehow changed it to a goddess called Artemis and Phoebe, daughter of Zeus and Leto, while the Romans named it Diana, Luna and Phoebe—the radiant one, daughter of Jupiter and Latona and sister of Phoebus Apollo.

Myth—The huntress Diana, goddess of the chase and provider of sustenance for all living things, once fell in love with the beautiful sleeping shepherd lad Endymion, who was gifted with eternal youth but also overcome by continual sleep. While he slept she lovingly tended his flocks and herds. The worship of Diana was widespread in the Roman Empire and her remarkable temple at Ephesus was considered one of the seven wonders of the ancient world.

Symbol—☽ A crescent is the usual symbol, but the half (☾, ☽) and the full and the dark faces ☺ ● are used for the quarter and full and new phases.

Colour—The colour of the moon, like that of the sun, varies greatly and ranges from silvery white to deep red, according to its position with reference to the sun, its phase and the condition and density of our atmosphere.

Markings—Observed by the unaided eye, the surface shows large shaded and smaller brilliant areas. The "man in the moon" is an optical illusion, not visible in a telescope. The ancients said he was put there for chopping wood on Sunday. The "woman in the moon", the "rabbit" of the Hindus and the "monkey" of the Chinese are in the same class. Through a telescope they appear as old sea basins from which the water has disappeared. One may also see some mountain ranges and many extinct volcanic craters. The irregular division between sunlight and shadow is called the terminator and it is sharp because there is no atmosphere to provide twilight as on the earth.

Stellar Magnitude—At full moon it is −12.55, or about one-half that of the sun and ten times that of Sirius; but these numbers do not express the ratios of their brightnesses. Of course it is less at the other phases.

Angular Diameter—This apparent diameter varies greatly; at perigee it is 32′ 56″, mean 31′ 5″, and at apogee 29′ 31″ of arc. The horizontal parallax is about 1°. We have all noticed that it seems clearer on the meridian than at the horizon, and larger at the horizon than on the meridian. The former is due largely to the greater density and thickness of the atmosphere through which we view it. The latter is an optical illusion.

Linear Diameter—The actual diameter is 2,163 miles or a little more than a quarter of our earth's. Its circumference is about 6,795 miles. What an interesting little world it would be!

Area of Surface—This is about 0.077 or 1/13 of the earth's or 15,151,700 square miles, *i.e.*, about the size of the land surface of our western hemisphere.

Volume—The cubical content is about 0.0204 or 1/49 of the earth's, or in the neighborhood of 5,198,880,000 cubic miles. If this could be spread evenly over the earth it would form a layer 26 miles thick.

Mass—This is about 0.0123 or 1/81 of the earth's, or about 75,000,000,000,000,000,000 tons, *i.e.*, about 1/30,000,000 of the sun. The centre of gravity of the earth-moon system is within the earth, about 1,000 miles from the surface.

Density—About 3.39 of water or 3/5 of the earth's. This is found by dividing the mass by the volume.

Surface Gravity—About 0.16 or 1/6 of the earth's. A person weighing 120 pounds here would weigh only 20 pounds there. One could jump 30 feet high and 30 yards long. The average speed of falling bodies is about 2.6 feet for the first second as compared with 16.07 feet here.

Velocity of Escape—About 1.5 miles per second as compared with 6.95 miles on the earth. This, like the gravity, is about 1 to 6.

Rotation Period—27 dy. 7 hr. 43 min. 11.5 sec. This is the same as the sidereal period and thus the moon always presents the same hemisphere to us, which is proved by the fact that the markings we see are always the same. But there are some librations which help us to see a little more than half the surface.

Equatorial Velocity—This is unusually slow, there being but one rotation in about 28 days. The equatorial speed, which is about 10 miles per hour, is constant, while the orbital speed is not so.

Oblateness—There seems to be no appreciable polar flattening or equatorial bulge and this is no doubt due to the slow rotation.

Inclination Equator to Orbit—6°41′. This is the sum of the angles of inclination of the planes of the moon's orbit and equator to the plane of the ecliptic.

Atmosphere—There is no known air envelope surrounding the moon, no cloud or fog has ever been seen. Without air there can be no sound and without water there can be no vegetation. Without wind or water there can be but little erosion. Thus no change has been seen on the surface. On account of the lack of atmosphere the sun beats down through a two-weeks' day with torrid intensity, and then when the two-weeks' night approaches the heat quickly dissipates into space and all becomes black darkness and bitter cold. At this time the other side, which we never see, enjoys its two weeks' period of torrid temperature.

Albedo—Mean 0.07. This ratio of reflecting power makes our silver satellite an ideal moon and caused the ancient Persians to call it the mirror of the earth.

Temperature—The moon is evidently a dead planet whose only source of heat is the sun. During its long clear day it receives so much heat that its temperature rises to about 115° C. or 239° F., while during its long cold night its temperature drops to about −80°C. or −112° F. The amount of heat reflected to us is negligible.

Radiation—The moon receives about the same amount of sunlight and heat, per unit area, as the earth, the average per month being about 1/1,000,000 of what we receive from the sun. In other words we receive as much from the sun in thirteen seconds as we get from the moon in a whole year. Even at full phase it reflects to us only about 1/600,000 of what the sun sends us. The effect of such small amounts of reflected light and heat is imperceptible.

Librations in Latitude—These are slow nodding motions of the poles. The inclination of the moon's equator to its orbit is 6° 41″, so that during each revolution its poles are gradually tilted each

way until at maximum we can see a little more than 6° beyond them, thus adding to the amount of surface visible.

Librations in Longitude—These are slow east and west equatorial shifts due to the combination of the constant speed of rotation and the variable speed of revolution, so that we are able to see a little more of each edge, which again adds to the amount of surface visible. Besides these there is a small diurnal libration due to the earth's rotation. Altogether it is possible to observe about 60% of the moon's surface or an area the size of North America, while the remaining 40%, about the size of S. America, is always hidden from us.

Distance from Earth—At perigee, 225,700 miles; at apogee, 253,000 miles; mean, 238,860 miles. The mean distance from surface to surface is about 220,000 miles. The mean diameter of its orbit is about 477,700 miles and its circumference is more than 1,800,000 miles. Its shadow extends, on an average, 232,000 miles. At maximum it is much longer so that we occasionally have total solar eclipses.

Distance from Sun—This, of course, is about the same as the earth's. Its revolution round the sun along with the earth, together with its inclination and the attraction of the sun and earth, make its solar orbit very sinuous but it is always concave to the sun.

Sidereal Period—This period of revolution extends from the moment the moon leaves a star until it returns to that star and takes, on an average, 27 dy. 7 hr. 43 min. 11.5 sec., the variation being due to perturbations caused by the attraction of the sun and nearby planets, especially the former.

Synodic Period—During this period of revolution, which is usually determined from many eclipses, the moon passes from the sun apparently round the sky and back to the sun again. It is called a lunation and takes on an average 29 dy. 12 hr. 44 min. 2.8 sec. This is a lunar month and its greater length is due to the orbital motion of the earth which takes it 2 d. 5 h. beyond where it was at the first of the month. Its month is also its day and there are 12.37 of these lunar days in an earth year. The moon rises about 51 min. later each day, *i.e.*, it has an eastward daily motion of nearly 13° while the sun's apparent eastward motion, on account

of the earth's revolution, is about 1° per day, so that the moon overtakes the sun about 13 times a year.

Perturbations—These are small orbital variations due to the attraction of the sun and nearby planets. They sometimes amount to 1°.5 and cause a variation of between two and three hours in the moon's period of revolution. The regression of the line of nodes is one form of perturbation.

Orbital Velocity—This is about 2,289 miles per hour or 3,357 feet per second and is from west to east like all the planets, but must not be confused with its apparent motion from east to west which is due to the rotation of the earth. This speed, we must remember, is affected by the perturbations.

Eccentricity of Orbit—This ratio is 0.0549 or about 1/18, and accounts for the points of perigee and apogee. The eccentricity and the inclination make possible the occasional central solar eclipses and also affect the tides.

Inclination of Orbit to Ecliptic—Mean 5° 9′. If we subtract this from the one above we find that the plane of the moon's equator cuts the plane of the ecliptic at an angle of 1°32′, thus marking its nodes. The moon's orbital oscillation is between 5° and 5°17′35″ and covers 173 days.

Longitude of Ascending Node—Owing to the influence of the sun the moon's line of nodes rotates in about 18.6 years. This is the Metonic or Lunar cycle, after which the phases repeat in the same order though not at the same locations on the earth. This, of course, causes the nodes themselves to revolve in a westward or backward direction called the regression of the nodes. We therefore do not set down any definite longitude but refer the reader to some good current almanac.

Longitude of Perigee—Like the nodes, the line of apsides which joins the points of perigee and apogee, is also in motion and rotates in about 8.85 years, so that these points are revolved in the same period. We therefore do not set down any definite longitude.

Elongation—This is the difference of longitude between the positions of the sun and moon.

Conjunction—The moon is in conjunction with the sun when their longitudes are equal. Then the elongation is 0° and the moon

new. The moon is in conjunction with a planet when their right ascensions are the same.

Quadrature—This occurs at half moon, *i.e.*, at first and last quarters, and the elongation is 90° or 270°.

Opposition—The moon is in opposition to the sun when it is full; then the elongation is 180°. At conjunction and at opposition the moon is said to be in syzygy.

Occultations—These occur whenever the moon passes between us and some star or planet. They are frequent but only the most prominent are noted.

Phases—A phase is a change in the amount of the surface of the moon from which we receive reflected sunlight and depends on the apparent distance the sun and the moon are apart in the sky. Just before and just after new moon the dark side is toward us and we cannot see the lighted surface, but in the next few hours the new moon, in the form of a very thin crescent, with its back to the setting sun, becomes visible. This steadily increases for about seven days until it reaches first quarter when we see half its disk but only a quarter of its surface; then it passes through a similar period to full moon when we see all its disk or half its surface; now it decreases on its way to last quarter when we see the other half of its disk or quarter of its surface, and finally it comes to the position of new moon again. During the crescent phase one may see the earth-shine on the larger dark portion of the disk. Between first quarter and opposition and between opposition and last quarter the phase is more or less gibbous. When new she rises and sets with the sun, at first quarter she rises at noon and sets at midnight, when full she rises at sunset and sets at sunrise, at last quarter she rises at midnight and sets at noon. The harvest moon and the hunter's moon are easily explained for they depend on the daily retardation of 51 min. mentioned above. Sometimes this is much greater than at others, according to its position on the eastern horizon. In northern latitudes this is most marked during September when the horizon is nearly parallel with the moon's apparent path. If at this time the moon is full it will rise at about the same time for several nights, thus prolonging the duration of moonlight so favourable for harvesting. In October the conditions are much the same and then it is called the hunter's moon. Will someone explain the honeymoon?

Eclipses—Lunar eclipses occur whenever the full moon, in its revolution around the earth, passes into the earth's shadow. This can happen only when the earth is at or near one of the moon's nodes. There are two types of eclipse—partial and total. A partial lunar eclipse occurs when the sun is so far from the moon's node as to allow the moon to only partially hide in the earth's shadow. A total eclipse occurs when the sun is near the node so that the moon is wholly hidden in the earth's shadow which stretches out into space from 845,000 to 873,000 miles according to its orbital position. The diameter of the earth's shadow where the moon cuts it is about three times that of the moon, so that a total lunar eclipse may last about two hours. There is an interesting relation between solar and lunar eclipses because the moon has to do with both. About two weeks before or after a total eclipse of the sun there will usually be a partial eclipse of the moon, and about two weeks before or after a total eclipse of the moon there will always be a partial eclipse of the sun. There must be at least two solar eclipses each year and ordinarily there are also two lunar eclipses, but in the case of the latter it is possible that none may occur.

Life—The question of habitability has already been answered in our statement about the atmosphere, but there are those who still think that some type of creature or at least some kind of vegetation must exist on our satellite. There is by no means sufficient evidence for this view and we must wait until we have more powerful instruments or the moon itself comes back to the earth.

Sea Basins—As no water is present on the moon these large shaded areas must now be only arid valleys. As measured by comparison with the lunar disk they vary in size, as do our own great lakes, and one is perhaps as large as the Mediterranean sea. With a little study we can readily pick out Serenitatis, Imbrium, Crisium, and others.

Mountain Ranges—There are ten of these, which vary in height from 1,000 to 20,000 feet, one or two of them being nearly as high as our Mt. Everest. They are all, however, very slim and precipitous compared with ours. One soon learns to know the Apennines, the Alps and the Caucasus. Several of the most important have received names of great men, such as Leibnitz and Doerfel at the south and Huygens, also in that direction. If our mountains were in the

same proportion to the earth's radius they would be about three times as high as they now are.

Volcanic Craters—Whether volcanic or meteoric or both, the typical lunar crater is almost circular like a wheel with a hub in the centre. The rim is a small mountain range similar to those mentioned above, while the hub is usually a rugged mountainous mass like the rim. The basin is often as deep below the surrounding region as the rim is high above it and the diameter ranges from 5 to 50 times the depth. There are some 30,000 of these, many having diameters ten times as great as any crater on the earth, and they make the moon look like a victim of *big* pox. One can soon become acquainted with Ptolemy 115 miles across, Copernicus 56 miles, and Tycho 53 miles in diameter.

Rills and Rays—There are more than 1,000 of the rills or cracks still yawning open. Some are very crooked, others very straight. They vary in width from a few rods to two miles and in depth from a few yards to unknown distances and extend as much as 150 miles. There are also numerous rays which radiate from some of the larger craters like Tycho and look as if they had been cracks filled up with some shining material from below. These also stretch for many miles in all directions and still constitute a real problem for us.

Influences—A great variety of conditions on the earth have been blamed on the moon, some scientifically, others superstitiously. There is, of course, no question about the tidal effect of the moon's attraction and we have long since learned that the so-called spring tides are highest and occur twice a month in any month when the sun and moon in line exert their combined gravitational pull upon the elastic surface of the earth. The neap tides are lowest because they occur when the sun and moon apply their force in opposite directions. But long before the effect of the moon's mass was known, and even in our day, there were and are many curious fancies about the moon's influence. Its eclipses and phases and even its presence in the sky were supposed to affect the weather, seed germination, timber cutting, hog killing, egg laying and even the human nervous system to the point of producing lunacy if one should sleep in moonlight.

Strathroy, Ont.

DIANA'S RETURN

I've read in books, said Mother Earth,
  My daughter's coming home;
But when and how are Greek to me,
For though I read I cannot see
How men can tell her perigee,
  Say naught of when she'll come.

Astronomers are busy folks,
  Forever watching us;
Collaborating nights and days
About this old world and her ways,
About Diana's golden phase;
  Enough to make us cuss.

How do they know, how can they tell
  Such things may come to pass?
Great calculations they prepare,
With telescopes they watch her there
And measure by a spider's hair;
  There's no escape, alas.

But if she's coming as they say,
    Within a billion years;
I wonder if she'll stop and fret
About the limit Roche has set,
Or will she crash in fervent heat,
  That solid frame of hers.

'Tis fifty million years or more
  She's been away, you see,
Torn by a solar tidal wave,
Snatched from the ocean's mighty cave,
And held in chains just like a slave
  'Twixt yonder sun and me.

And when she comes, I'll take her to
  That selfsame spot again—
There she may sit upon my knee,
'Tween Golden Gate and Yellow Sea,
Where sunsets reach eternity
  That haunts the souls of men.

Though caught by stealthy thieves of space,
  She ne'er forgot her home;
But ever turned this way and smiled,
Just like a good obedient child,
And on my shores the tides uppiled,
  Though still compelled to roam.

The years have gone, the journey's done,
  Diana's home at last;
Through many a thousand leagues she hied,
With many a javelin in her side,
Flung by the fiery Sol who cried,
  I'll follow just as fast.

But what, my child, are all these marks?
  These blotches, pocks and spires?
Ah, Mother dear, I went alone
Through storms of flame and flying stone,
With fulminations of my own,
  Against those cosmic fires.

Alas, alas, I feel so strange
  Since you came back to me;
When in my arms I clasp your weight,
I feel I surely can't rotate
On tiptoe as I did of late.
  What must the reason be?

. . . . . .

The answer is not hard to guess,
  For when the Moon sits down,
There'll be a shock to Mother Earth
Like in the hour of Phoebe's birth,
And all around her giant girth
  A trembling to her crown.

Old Mother Earth with awful groan
  Will know her course is run;
She'll roll and wabble without aim
As solar forces grip her frame,
Only at last to yield in shame
  A captive of the sun.

The Moon will swell the sea of peace,
  But peace will then be gone;
Five thousand fathoms deep she'll sink,
And all the creatures on Earth's brink
Of Noah's flood will quickly think,
  And seek a safety zone.

But though she sinks so far below,
  She's high above the foam;
Above the waves, above the crowds,
Beyond the air our planet shrouds,
Two thousand miles above the clouds
  She rears her sunkissed dome.

And so the continents will change,
  The shorelines be renewed;
While round the Moon on every hand
Three thousand miles of water stand,
And make the widening seascape grand
  From every angle viewed.

For many a mile her swelling bilge
  Will overhang the sea;
Full many a score of miles away
Her darksome shadow hold its sway
And make a night within the day,
  O'er limpid lake and lea.

And then the eyes of all the world
  Will focus on the sight;
The scientists all wide awake
Will go to see this fact or fake
And many a picture draw and take
  To ponder through the night.

With speedy craft they'll fill the sea,
  The ships with eager men;
But as they reach that arid strand,
They'll find no shore on which to land,
No harbour fit for ships to stand,
  So they'll return again.

The airmen then like gulls will seek
  A place to disembark,
But ever and anon they'll fail,
Their efforts seem of no avail,
They never, never can assail
  That rugged ceiling dark.

Ah, what's the use, all say at last,
  Attempting such a chore?
Let's go back home to plod and grope,
To work, to ponder and to hope,
And meanwhile use the telescope
  As we have done before.

Strathroy, Ont., March 21, 1930 W. G. COLGROVE

SHOOTING STARS, THE STORY-TELLERS OF THE UNIVERSE*

By Charles P. Olivier

Everyone has frequently seen a shooting star or meteor, but few people know what they are. Even in our own supposedly educated country many persons still think meteors are real stars that have somehow broken loose from their moorings and taken a sudden journey across the sky. It is fairly safe to say that many other people do not take time to think about them at all, any more than they do about the fireflies of a summer night, which are sometimes mistaken for meteors.

However, there are many others—and I believe the growing majority—who have a real desire to know about the phenomena of nature. They want to know the causes and effects of what they see.

Meteors may be defined as the debris of evolution. For instance, after a great building has been constructed, all sorts of waste material are found, pieces of stone, brick, wood, scraps of steel, nails, etc. So after a solar system of planets and satellites, asteroids and comets, has been formed, waste material is left over. This becomes meteors. But a study of the scraps of material around a building would teach a man who was not allowed to see the edifice itself something about the completed structure. So the study of meteors leads to most important conclusions as to the evolution of the Solar System—and other similar systems in space.

Meteors are in general small bodies, far smaller than is generally thought. The faintest we see with the naked eye are probably no larger than a grain of sand, the larger ones may be as large as a boy's marble. Great fireballs, which are occasionally seen, are due to bodies of a few hundred pounds weight at most.

*Beginning on March 28, Science Service has presented a fifteen-minute series of Radio Talks weekly at 3.45 p.m. Eastern time over the Columbia Broadcasting System. On August 1, Professor Olivier spoke on meteors. The article printed herewith is a portion of the address as given in *Science News-Letter*.—Editor.

The Danger of Meteors

The average meteor is luckily destroyed by its passage through our atmosphere. Were it not so the earth would be uninhabitable, for 20 million (not counting vastly more numerous telescopic meteors) enter our atmosphere daily. They move with velocities of from about eight to 50 miles per second. A grain of sand moving with such a velocity would kill as surely as a shell from a rifled cannon, if it hit a vital spot. It would in any case certainly go right through the body of whoever was hit.

But the air, which extends upwards at least 200 miles, forms an elastic but impenetrable shield to most meteors. Only the largest get through, and these are so infrequent that we need scarcely fear them. When a meteor does penetrate to the earth's surface, it is called a meteorite. A few are found yearly, but there are few if any authentic accounts of a fatality therefrom. It is true that a big one did nearly strike two children in Hungary, some years ago. It fell through the ceiling of the room they were in, but did not harm them though smashing up everything else.

Again, four small stones fell in the neighborhood of a negro funeral procession about five years ago in Virginia. Except for a great scare among the mourners no damage was done. The speaker has handled these stones; they are about the size of a large orange and weigh only a few pounds each. Almost all large scientific museums have some meteorites on exhibition. The largest now in captivity may be found in the American Museum of Natural History in New York city. One weighs over 36 tons, is mostly of iron, and was (along with two somewhat smaller ones) brought back by Peary from Greenland. Their fall is not recorded, even in the traditions of the Eskimos, but their meteoric origin is quite certain, proved as it is by their locality and internal structure.

An even larger one has recently been found in southwest Africa, but no attempt has been made to move it. One still larger, of almost incredible dimensions as meteorites go, was reported a few years ago by a French military column, operating in the desert region of Morocco. The speaker has in vain sought to obtain further details about this object. Failure was probably due to the disturbed condition of that country, and the unwillingness of the

French to penetrate again into any battle region without imperative cause. But we all eagerly await more news about this monster.

If a person is in the open country with a clear sky, during the first six months of the average year, he should see from four to eight meteors per hour; during the second six months from eight to 15 per hour. Also he will see fewest at six p.m., most about two hours before sunrise. This rule holds all the year. This last fact is due to a question of relative velocity, a geometrical or physical problem fully understood. The smaller numbers met in the first half of the year is obviously explainable by the mere fact that there are less meteors to be met in the regions then traversed by the earth, as well as to the position of the meteoric apex as seen in the northern hemisphere. Again the richest annual showers come in the second half of the year, for instance: Delta Aquarids in late July, Perseids late July and August, Orionids in October, Leonids and Bielids in November, Geminids in December.

Meteors come to us from two sources, some from our own solar system, others from outer space. A sharp line can be drawn between them, for if a meteor passes our orbit with a velocity much under 26 miles per second, it is a home product, as it were. But if the velocity is over 26 miles per second it originated in some distant stellar system, and has traversed immeasurable reaches of space to come to us.

Visible Only in Atmosphere

Of course we see none of the innumerable meteors that pass us by closely, much less those at a distance. Only when the meteor plunges into our atmosphere does it become visible, due to the sudden turning of its great kinetic energy of motion into light and heat. Even then the most of its light and apparent size come from the envelope of superheated air which it carries along with it. For instance, the speaker has seen more than one fireball which had the apparent size of one half the moon's diameter, *i.e.*, 15′, or approximately 1/230 of a radian. Therefore if the object was 50 miles away—and it was actually farther—that would mean the fireball was 1,150 feet in diameter. Probably the solid mass was of the

order of one foot, not 1,150. Then the extra apparent size was due to heated gas around it, and also to a lesser extent to irradiation.

The beautiful trains left by some bright meteors were once thought to be actual sparks left behind. We now know such an explanation is absurd, for some of these remain visible a quarter of an hour or more. It appears most probable that they are due to phosphorescence. The long enduring ones seem sharply limited to the stratum between 45 and 65 miles above the ground. They do not last long higher up, and those very much lower are actual trains of smoke, which show up by reflected sunlight. These latter are seen only after the passage of a great fireball in the daytime, for of course there are as many meteors during the day at at night, only we do not see them.

Many meteors, particularly members of some of the main streams which give us the annual showers, follow the same orbits as do certain comets. For instance, the Perseids, seen in greatest numbers on August 11 or 12, follow Tuttle's comet. The Leonids, the most famous stream of all, for they give the "great showers" as of 1833, when it was said "the stars fell", follow the path of Tempel's comet; the Bielids that of Biela's comet, the May Aquarids that of Halley's comet, etc.

Comets Make Meteors

This connection between comets and meteors has proved of great importance in our study of the former, for we are quite sure that the nuclei or central parts of the heads of comets consist of nothing other than meteorites. And when a comet disintegrates, which apparently will be the ultimate fate of all comets, its debris simply becomes meteors. Hence the Mazapil meteorite, which fell during a shower of Bielid meteors in 1885, is rather confidently spoken of as a part of Biela's comet.

The study of meteors from the observational standpoint takes up so much time that professional astronomers cannot spare enough from their great telescopes to do much on meteors. Hence their actual observation is rather largely left to amateurs. In this country we have a flourishing organization known as the American Meteor Society, formed mostly of amateurs, but with some profess-

ional astronomers also. The headquarters is at the Flower Observatory of the University of Pennsylvania, of which the speaker is director. All the members send to us copies of their observations which are then carefully worked up and the results published at intervals. In this way we are able to coordinate and discuss the work more fully than any individual could do, using only his personal observations and experience.

Besides our regular members we aim to secure the help of all others, even temporarily interested. Such observers cannot, as a rule, send in as complete observations as our trained members, but they can do something very useful indeed. This is to help us get the hourly rates of all meteors, from widely scattered stations. From such data we are able to deduce a true picture of the destiny of the cross-section of the meteor stream, and tell more about it generally.

To do this one should choose a favourable place, and provide himself with a watch, notebook, flashlight and pencil. Then, watching as large an area of the sky as possible, he should count every meteor certainly seen during each half hour. As each interval is up, the record should be made in the notebook, along with notes as to any changes in the sky like passing clouds, etc., or any especially fine meteor seen. The watching should be done toward one direction only, during each half hour. What direction it is should be recorded. If desired, other directions may be chosen for other half-hours. No meteor should be counted unless seen with certainty. Full notes as to condition of the sky should always be made.

Such records, conscientiously made by intelligent people, over periods of two or more hours near the dates of maximum of the Perseids, for instance, have a real value as explained above. When reported to us, they are published in due time, proper acknowledgments being made to each contributor, by name, in the publication. We also desire all observations of any very bright meteor, casually seen, no matter on what night.

For those who would like to take part in more detailed observations than those briefly outlined, a request mailed to the Flower Observatory, Upper Darby, Pa., will bring a bulletin with further

instructions and descriptions of the work of the American Meteor Society.

Great Showers Coming

Finally, it is quite possible, if not probable, that 1932, 1933, or 1934 may see the Leonids return in sufficient strength to give again one of the truly great meteoric showers. They come about the middle of November. As world-wide preparations will doubtless be made for their observation, we desire some years ahead to interest and train a large corps of volunteer observers, who will be available if indeed a magnificent display should appear. This is an added reason for the increasing attention being paid to meteoric astronomy.

REVIEW OF PUBLICATIONS

Determination of Orbits of Comets and Asteroids, by Russell Tracy Crawford. 229 pages, 7×10 in. N.Y., Mc Graw-Hill Book Co. Price, $4.00. 1930.

This book might be called the *a b c* of orbit determination. Very much less elaborate than the comprehensive treatment of the subject as given in works such as those of Klinkerfues, Oppolzer or Bauschinger, it contains all the essentials of both the Laplacian and Gaussian methods, the former as simplified by Leuschner and the latter as modified by Merton. It is intended as a text for the beginner and serves the purpose better than any other book I have seen. For the first time we have a book which can be presented within the scope of a course of lectures in a single year. Elaborate theoretical discussions are largely omitted—the correct procedure in writing a text. The teacher can elaborate such points as they are raised by the enquiring student. Everywhere the book shows the stamp of having been written by a practical computer, and the examples are well chosen and clearly worked out.

The inclusion of a few more diagrams, however, would make the derivation of some of the formulae easier for the student. No attempt has been made to adapt the formulae for computation with a machine. I think the book would be improved by indicating such modifications where possible. The book is printed on good paper and well bound.

R. K. Y.

Barlow's Tables. Third edition, by L. J. Comrie, M.A., Ph.D. 208 pages, 8½×5¼ in. London, E. & F. N. Spon, Ltd. Price, 7/6 net.

This very useful book of tables, so well known to computers, has been revised and enlarged in the third edition. It retains intact all

the valuable features of the old edition and has been improved by the following additions.

For the numbers 1000-10000 a new column showing the root of ten times the number has been added. This practically extends the accuracy to another figure.

Interlinear differences are provided in the columns of square roots, cube roots and reciprocals, which is a great improvement.

Several tables not found in the second edition have been added. These include $n!$ to 100 and n^4 and $n^{-\frac{1}{4}}$ to 1000 and powers up to n^{10} to 100 and n^{20} to 10.

Barlow's Tables are extremely useful to all computers who make use of a calculating machine.

R. K. Y.

NEWS AND COMMENTS

Dr. Leslie J. Comrie, deputy superintendent since 1925 of the Nautical Almanac Office, has been appointed superintendent of the office in succession to Dr. P. H. Cowell, who has retired under the age limit after twenty years' service.—(*Nature*).

Dr. J. A. Carroll, assistant director of the Solar Physics Observatory, Cambridge, has been appointed professor of natural philosophy in the University of Aberdeen in succession to Prof. G. P. Thomson.

Dr. Heber D. Curtis, Director of the Allegheny Observatory, has been appointed Director of the Observatory and Head of the Department of Astronomy of the University of Michigan, and will assume his new duties on October 15. Dr. Frank C. Jordan, who has been a member of the staff of the Allegheny Observatory since 1908, first as Astronomer and later as Assistant Director, has been appointed Director of the Allegheny Observatory, and Dr. Keivin Burns has been appointed Assistant Director.

The French Astronomical Society has decided to award a medal of honour to the Lowell Observatory at Flagstaff, Arizona, as an expression of appreciation and admiration for the discovery of the trans-Neptunian body, preparation for which was made by the learned research of Lowell.

Father John George Hagen, S.J., after an illness of several months, died in Rome on September 6, at the age of eighty-three. Father Hagen was formerly director of the Georgetown College Observatory, and for the last twenty years had been director of the Vatican Observatory. Father Stein, S.J., has been appointed as his successor in the directorship of this observatory.

Dr. Philip Fox, director of the Adler Planetarium, Chicago, had the degree of doctor of laws conferred upon him by Drake University at its forty-ninth commencement.

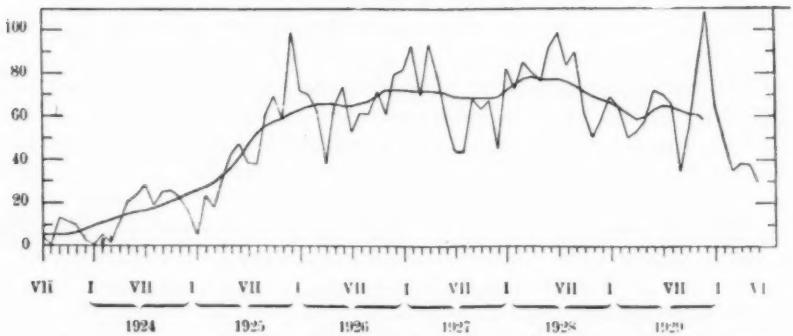
REDeL.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

The Last Sun-spot Maximum

As is well known, the curves representing the successive sun-spot maxima differ much in appearance, and the intervals between the maxima also vary. The recent maximum was of a very undecided nature, there being no outstanding season of solar activity. But it is now well past and Professor Brunner, of Zurich, has been able to analyse all the observations and determine the precise way in which the spottedness changed. In No. 124 of the long



Curve of the observed and the adjusted monthly relative numbers for sun-spottedness from 1923 to 1930.

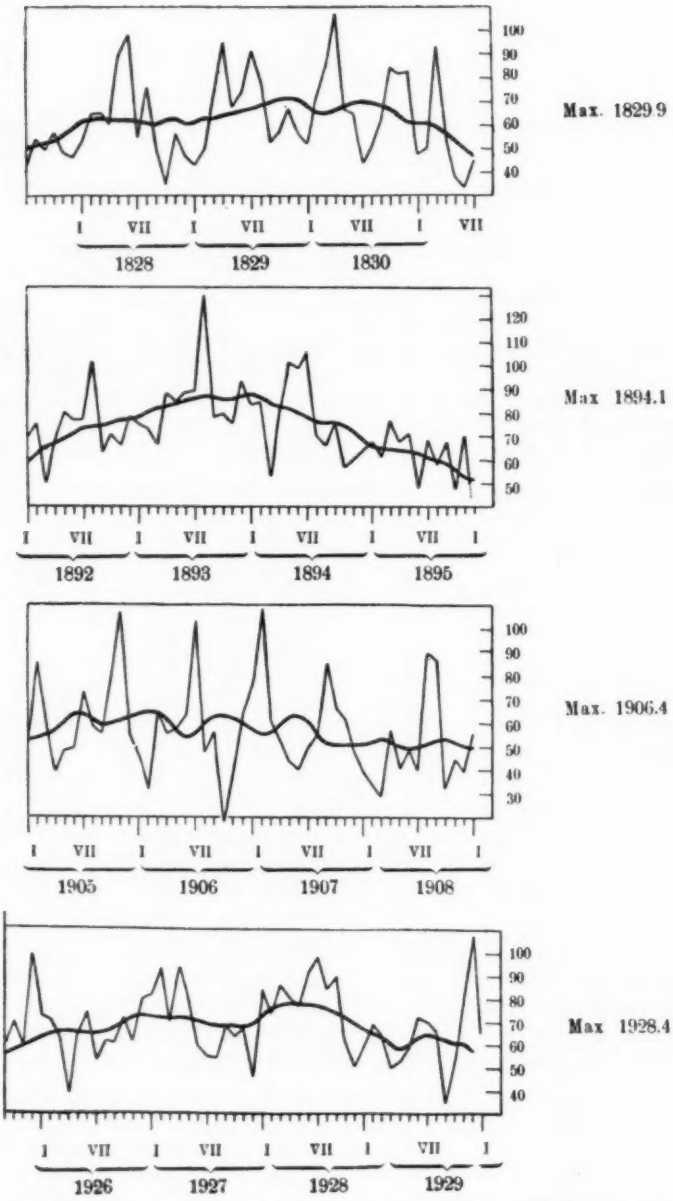
series of *Astronomische Mitteilungen*, originated by Wolf, the curve of the monthly relative sun-spot numbers from 1923 to 1930 is given, and it is reproduced herewith. Brunner gives 1928.4 as the date of the chief maximum.

Somewhat similar maxima have been observed in past years and four of them are also given herewith.

It may be interesting to quote in addition the table of maxima and minima supplied in the same paper.

EPOCHS OF MAXIMUM AND MINIMUM SUN-SPOTS

Maxima				Minima			
Epoch	Wt.	Period	Grtst. monthly Rel. Number	Epoch	Wt.	Period	Grtst. monthly Rel. Number
1615.5	2	....	....	1610.8	5	....	....
1626.0	5	10.5	....	1619.0	1	8.2	....
1639.5	2	13.5	....	1634.0	2	15.0	....
1649.0	1	9.5	....	1645.0	5	11.0	....
1660.0	1	11.0	....	1655.0	1	10.0	....
1675.0	2	15.0	....	1666.0	2	11.0	....
1685.0	2	10.0	....	1679.5	2	13.5	....
1693.0	1	8.0	....	1689.5	2	10.0	....
1705.5	4	12.5	....	1698.0	1	8.5	....
1718.2	6	12.7	....	1712.0	3	14.0	....
1727.5	4	9.3	....	1723.5	2	11.5	....
1738.7	2	11.2	....	1734.0	2	10.5	....
1750.3	7	11.6	92.6	1745.0	2	11.0	....
1761.5	7	11.2	86.5	1755.2	9	10.2	8.4
1769.7	8	8.2	115.8	1766.5	5	11.3	11.2
1778.4	5	8.7	158.5	1775.5	7	9.0	7.2
1788.1	4	9.7	141.2	1784.7	4	9.2	9.5
1805.2	5	17.1	49.2	1798.3	9	13.6	3.2
1816.4	8	11.2	48.7	1810.6	8	12.3	0.0
1829.9	10	13.5	71.7	1823.3	10	12.7	0.1
1837.2	10	7.3	146.9	1833.9	10	10.6	7.3
1848.1	10	10.9	131.6	1843.5	10	9.6	10.5
1860.1	10	12.0	97.9	1856.0	10	12.5	3.2
1870.6	10	10.5	140.5	1867.2	10	11.2	5.2
1883.9	10	13.3	74.6	1878.9	10	11.7	2.2
1894.1	10	10.2	87.9	1889.6	10	10.7	5.0
1906.4	10	12.3	64.2	1901.7	10	12.1	2.6
1917.6	10	11.2	105.4	1913.6	10	11.9	0.0
1928.4	10	10.8	78.1	1923.6	10	10.0	5.6



Examples of secondary maxima in the curve of sun-spottedness—The numbers at the right-hand are Wolf's relative numbers.

Relating to the Sky or the Sea?

At the recent meeting of the American Astronomical Society in Chicago two of the papers presented were:

W. E. Harper: Notes on spectroscopic binaries.....10 min.
J. A. Pearce: Redetermination of the elements of the galactic rotation from 790 O- and B-type stars (lantern).....15 min.

A telegram giving these titles was despatched from the Dominion Astrophysical Observatory to the secretary of the society, but at the time he was in the woods of Maine far from a telegraph office. The operator, however, was anxious to complete his task and managed to reach a native living near the sea who was willing to take the message and then to carry it a considerable distance to Professor Dugan. The text which reached the latter was as follows:

Harper's notes from stereoptic barnacles.
Rediscovery of elegance of Galapagos Rotadon by star Tierce 790 O and B type in 15 minutes with lantern.

Swapping Stars

How can those who live out where stars are stars and where the Milky Way is really milky, secure personal introductions to the planets and prominent stars, in the absence of a nearby amateur outdoor astronomy club; or who, worse still, live too far from Chicago's wonderful indoor sky-show known as the Max Adler planetarium?

Easy enough! On the next clear night, prove your organizing ability by inquiring of any outdoor group, "Does any one know that bright star yonder well enough to introduce me to it?" Sooner or later, possibly later, some one will say, "I do not know that one, but I do know the Big Dipper. There it is right up there."

If you happen to be acquainted with the Northern Crown or the sky airplane known as the Northern Cross, or any other group or constellation in sight at the time, at once say, "Now, won't you let me present my sky friends (naming the constellation)?"

Then get that person to promise to get in touch with you just as soon as they, following your technique, meet other star-minded people and their sky friends. You be sure to do likewise.

Stamp collectors swap stamps right along; and you, by thus swapping stars, will in a short time secure two fine collections, one of stars and the other of very pleasing friends.—

HENRY DILL BENNER, 77 Heller Parkway, Newark, N.J.

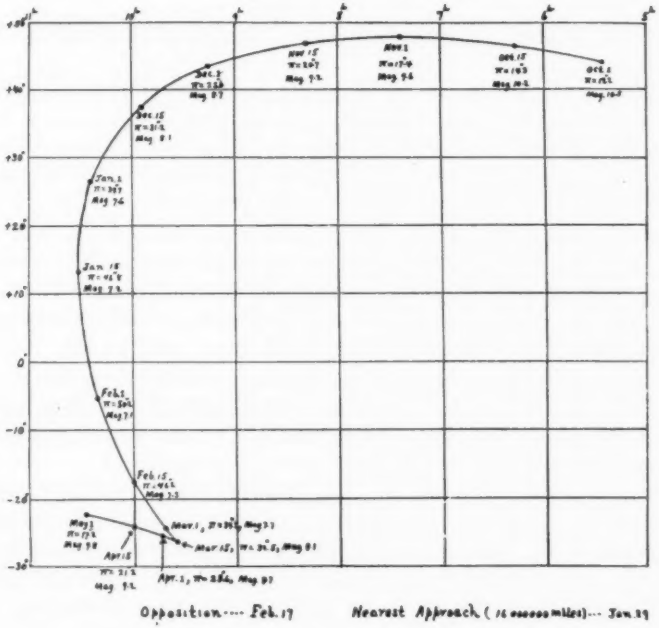
THE EROS CAMPAIGN

At the present time an intensive campaign of observation is being directed against the little planet Eros. This small body, also known as No. 433 of the family of asteroids, was discovered on August 13, 1898, by G. Witt at the Urania Observatory, Berlin. On the photograph which he obtained it showed a brightness of the 11th magnitude and a retrograde motion of half a degree a day. Soon afterwards E. C. Pickering recognized its image on 21 plates taken in 1893, 1894 and 1896, and the calculation of its orbit showed that its mean distance from the sun is only 1.46, while that of Mars is 1.52. A large part of the orbit of Eros lies inside that of Mars. The eccentricity of its orbit is 0.22, which is fairly large. Its inclination is $10\frac{3}{4}°$, but its descending node is only $2\frac{1}{4}°$ from its perihelion, and when the planet is at its node it is in the same direction from the sun that the earth is in on January 22. If Eros should come to opposition on that date its distance from the earth would be within 14 million miles, which is closer than any other planet approaches the earth.

The period of Eros is 643 days while that of Mars is 687, and Eros comes to opposition, on the average, at intervals of 845 days. Three of these synodic periods fall short of 7 years by 3 weeks. Only rarely is the planet in opposition at the same time that it is near its perihelion. This happened in 1894, unfortunately before the discovery of the planet. Its brightness then was 6.5 mag. There was a moderately favourable opposition in 1900-01, when the minimum distance was about 30 million miles. The coming opposition will be on January 29, 1931, but the nearest approach to the earth, according to Hammond, is on the same date. Its distance will be $16\frac{1}{4}$ million miles and its magnitude will be 7.1—easily visible in a field glass. The body itself is probably not greater than 20 miles in diameter.

Eros is of special value to the astronomer because, coming so

close to the earth, its parallax can then be measured very accurately and the distance of the sun can be deduced. In 1900-01, a large number of photographs of the planet among its surrounding stars were secured at various observatories in different parts of the earth, and the positions of many stars along its path were measured by several astronomers—notably R. H. Tucker at Lick Observatory



Path of Eros from Oct. 1, 1930, to May 1, 1931.

and A. Kopff at Berlin. A discussion of all the material by A. R. Hinks gave for the solar parallax 8.″806, and this is considered one of the best determinations made. Another determination of great accuracy will no doubt follow from the present season's work. As by-products of the measurements an excellent value of the moon's mass has been obtained, and in the course of time the earth's mass in terms of the sun will be deduced.

At the recent meeting of the American Astronomical Society, a paper on the coming opposition, by J. C. Hammond of the U.S. Naval Observatory, was presented, and in it there was an accurate chart of the planet's path, together with its computed parallax at different points. By permission, it is reproduced herewith.

NUMERICAL RELATIONS IN THE SYSTEM OF MARS

(By HENRY W. ENGLISH, Jacksonville, Illinois.)

The two tiny satellites which revolve around Mars display interesting phenomena, as perhaps every one knows who has read the account of their discovery in 1877 by Professor Hall, of the Naval Observatory at Washington, D.C.

Phobos, which has a revolution period of less than one-third of the rotation period of its primary, is a thing unique, and an anomaly in nature. However, there are other facts quite uncanny, and which may have strange significance.

Consider the following: Phobos illuminates that portion of the surface of Mars which multiplied by 3.14159. . . . (the ratio between circumference and diameter of a circle) would equal the area of the whole surface of Mars.

In other words: The diameter of the orbit of Phobos, divided by the distance from the surface of Mars to said orbit, equals 3.14159 . . . . Thus the diameter of the orbit, considered as a flexible rod and bent into the form of a circle could be rolled upon the surface of Mars and also be tangent to the orbit of Phobos.

From this we may learn an interesting theorem in trigonometry, to wit: If a point is located outside a sphere in such a relative position that if the distance between the surface of the sphere and point multiplied by x equals twice the distance of point from centre of sphere, then the area of the whole surface of sphere equals x times the area of the surface which is visible from said point.

No one, of course, is able to state positively whether this peculiar ratio actually does exist. The following table shows the complementary elements necessary to bring about a close approximation:

Radius of Phobos:	Diameter of Mars:
5850 miles	4251.54 miles
5840 "	4244.3 "
5830 "	4237.00 "
5820 "	4229.74 "
5810 "	4222.5 "
5800 "	4215.2 "

The *American Ephemeris* has recently adopted 4215.56 miles as the diameter of Mars. No effort seems to have been made to determine the radius of the orbit of Phobos with any degree of precision; it is generally given as 5850 miles or 5800 miles, indifferently.

The writer has more than a suspicion that Mars has something to say if we will give him a little attention.

Note on the Above.—At the request of the present writer, his colleague, Professor Young, checked the above statements. If a point P, outside a sphere of radius a, is distant d from its centre, then the area of the spherical surface visible from P is $2\pi a^2(1-a/d)$. If now $(d-a)x=2d$, the relation given above, this area becomes $4\pi a^2 x$. In the *Encyc. Brit.*, 14th ed., Art. "Mars," the best determined values of the diameter of Mars are given as 4190 miles (telescopic) and 4128 (photographic); and for the above ratio to be exactly π the distance of Phobos would have to be less than 5800 miles, the least value assigned to it. On the other hand, Russell, Dugan and Stewart gave 5826 miles as the distance. Professor Young also remarks that the orbit of Phobos has an appreciable eccentricity and hence the ratio cannot be exact at all times. This would strengthen the conclusion that it is not exactly π and has no real significance.

Photograph of a Rainbow

Attention is directed to Plate XXVII, in which is reproduced a photograph of a rainbow taken at the Observatory of the Ebro in Spain and kindly forwarded by Father Rodés.

C.A.C.

MEETINGS OF THE SOCIETY

At Toronto

May 13, 1930.—The regular meeting was held in the Physics Building of the University of Toronto, at 8 p.m., Mr. R. A. Gray in the chair.

Moved by Mr. A. F. Hunter, seconded by Mr. R. S. Duncan, that a committee composed of Dr. C. A. Chant, Mr. A. F. Miller, and Mr. J. R. Collins draft a suitable letter of condolence to the widow of the late esteemed member, Mr. John A. Paterson. *Carried.*

Mr. Gray remarked that our usual chairman and several other members were at Hamilton this evening attending the first meeting of the new centre there.

There were five elected to membership:—

William H. Gardner, Box 181, Ellet, Ohio, U.S.A.
Percy Robertson, 2 Oaklands Avenue, Toronto.
Gordon Hepburn, 113½ Soudan Avenue, Toronto.
John Schuler, Meadville, Penn., U.S.A.
Willis J. Hall, 511 28th St., Union City, N.J., U.S.A.

In the absence of Mr. Duncan, Mr. Fred Troyer was asked to speak on the advertised subject, "Ursa Major," of which he then gave a good description, with lantern slides.

Mr. A. F. Hunter gave an address on "Auroral and Earthquake Phenomena," in which he referred to the points to be noted by observers who are inclined to take part with the observational section for the aurora, newly instituted to stimulate interest in the work of the Society. As an example of the points to be noted, he read a description of the aurora visible on the night of May 4. In the British Association Report for 1929 there is a calculation for the earthquake of Feb. 28, 1925, which is estimated as having originated at a depth of about 40 miles, near the Saguenay river almost due north of Quebec City. The speaker also referred to the earthquake phenomena of the past nine months, which had been important and numerous. That of August 12 last was most pronounced south of Erie City, Penn., although quite distinctly felt at Toronto by the narrator. That of Nov. 18 last, about 180 miles southeast of Newfoundland, was followed two days later by a destructive tidal wave on the south coast of the Island Colony, with considerable loss of life and property, and many of the cable lines were snapped by the quake. The recent earthquake in Burma has been attended by great loss of life, if the desptaches were reliable. The Annual Report of the British Association contains valuable data of the Seismological Committee which began its work in 1896 and whose decisions on earthquake phenomena have been leading the world in this particular. A new electrical device is able to make

soundings by electricity into the earth to a depth of about thirty miles to determine the nature of the layers passed through to that depth.

Mr. M. S. Groh gave some interesting examples of the intensity of the light given by a tungsten lamp.

Mr. H. L. Rogers gave his impressions of the opening exercises of the new Planetarium at Chicago.

At Hamilton

On Tuesday, May 13th, 1930, the lecture hall of the Hamilton Public Library was comfortably filled for the first meeting since organization of the Hamilton Centre of the Royal Astronomical Society of Canada.

The President opened the meeting with a few words of welcome to the membership and visitors with the expressed hope that this meeting should be one of many such under the R.A.S.C. auspices in the future. Then giving a brief report of the local Council meeting, the President announced that the second Tuesday of each month would be the regular meeting night of the Society, excepting July and August, with the further exception of the month of June, when the Society will hold an open meeting at the home of Mr. W. T. Goddard, where seven telescopes will be set up for the use of the Society.

Mr. T. H. Wingham was then heard in an interesting five-minute talk on the "Sky for the Month of May," after which Rev. Dr. Marsh, Hon. President of the local Centre, very aptly introduced the guest lecturers for the evening: Prof. R. H. Kingston, Western University, London, President of the whole Society; Prof. C. A. Chant, University of Toronto, Past President; Prof. R. K. Young, University of Toronto, Vice-President; Mr. J. R. Collins, President of the Toronto Centre.

Prof. Kingston, in bringing the greetings of the general society, congratulated the Hamilton Centre on their splendid work of organization, and speaking of the work of the Society in all its phases throughout Canada, pointed out the growth of scientific thought in the minds of people in the last decade.

Prof. R. K. Young in his address, "The Recent Discovery of Probable Planets," used photographs and charts showing details and probable orbit of the Trans-Neptunian Planet X. Prof. Young has done valuable work on computations of orbits of various bodies and his remarks on the work of Lowell Observatory on the new planet were most interesting to his audience.

Prof. Chant followed with a concise history of astronomy from the early time of Hipparchus, Copernicus, Galileo, Kepler and Newton down to the present day, telling in a most interesting manner of the growth in the minds of the early students of the conceptions of the universe as they changed from age to age. Prof. Chant specified the greatest event of modern times in the science of astronomy to be the advent of the spectroscope for sun and star analysis and the recent advances in the art of building powerful telescopes.

Mr. J. R. Collins expressed the felicitations of the Toronto Centre and the promise of co-operation from that body; after which the President declared the meeting adjourned.

On Tuesday night, June 3rd, the weather man favoured the Hamilton Centre with a very fine sky for their open meeting, the first of the year, held on the spacious grounds of Mr. and Mrs. W. T. Goddard.

About one hundred members of the Society and their friends made the fullest use of the five telescopes set up for observation and the evening was one of much enjoyment.

The moon, placed high in the heavens, was a beautiful sight and its craters and mountain ranges occasioned many exclamations of delight from those witnessing the spectacle for the first time. Venus, the only planet visible, was too low down for good observation, but much interest was shown in double stars, like Mizar, Epsilon Lyrae and Albireo, whereas the prominent fixed stars visible, Arcturus, Vega and Regulus, came in for their share of attention.

Comprising the equipment on the grounds were telescopes owned by Messrs. C. E. Bull, T. H. Wingham, H. G. Smith and J. A. Marsh, with the interest chiefly centered around the big refractor owned by Mr. W. T. Goddard. Rev. Dr. Marsh, operating this instrument, demonstrated how the moon was photographed and was very happy in his demonstration of how the astronomer picks up star clusters and nebula not visible to the naked eye by the use of graduated circles and star time.

Many interesting discussions were heard during the evening, such as star distances, the size of the craters on the moon, the limits of our universe, etc.; and those in charge of the telescopes, T. H. Wingham, W. H. Mallory, Geo. Campbell and Dr. Marsh, contributed much to the enjoyment of the evening with their comments.

At the conclusion of the programme light refreshments were served and the Society tendered their thanks to Mr. and Mrs. Goddard as host and hostess.

The President announced that the next meeting would be held in September when Prof. H. R. Kingston, of Western University, would be the guest lecturer, his subject being "The Milky Way and Beyond."

The Royal Astronomical Society of Canada

OFFICERS FOR 1930

Honorary President—J. S. Plaskett, B.A., D.Sc., F.R.S., Victoria, B.C.
President—H. R. Kingston, M.A., Ph.D., London, Ont.
First Vice-President—R. K. Young, Ph.D., Toronto.
Second Vice-President—Mgr. C. P. Choquette, M.A., Lic.Ses., Montreal.
General Secretary—Lachlan Gilchrist, M.A., Ph.D., 198 College St., Toronto.
General Treasurer—H. W. Barker, 198 College St., Toronto.
Recorder—E. J. A. Kennedy, Toronto.
Librarian—C. A. Chant, M.A., Ph.D., Toronto.
Curator—Robert S. Duncan, Toronto.
Council—D. S. Ainslie, M.A., Ph.D., London, Ont.; Napier Denison, Victoria, B.C.; Miss A. Vibert Douglas, Ph.D., Montreal; R. E. DeLury, M.A., Ph.D., Ottawa; R. A. Gray, B.A., Toronto; E. A. Hodgson, M.A., Ottawa; J. A. Pearce, M.A., Victoria, B.C.; J. Patterson, M.A., Toronto; John Satterly, M.A., D.Sc., Toronto; L. A. H. Warren, M.A., Ph.D., Winnipeg; and Past Presidents—Sir Frederic Stupart, F.R.S.C.; A. T. DeLury, M.A.; L. B. Stewart, D.T.S.; Allan F. Miller; J. R. Collins; W. E. W. Jackson, M.A.; R. M. Stewart, M.A.; A. F. Hunter, M.A.; W. E. Harper, M.A.; and the Presiding Officer of each Centre as follows—C. C. Smith, B.A., D.L.S., Ottawa; Dr. A. H. MacCordick, Montreal; L. A. H. Warren, M.A., Ph.D., Winnipeg; C. S. Beals, M.A., Ph.D., Victoria; H. R. Kingston, M.A., Ph.D., London, Ont.; J. A. Marsh, Hamilton.

TORONTO CENTRE

Honorary President—Sir Frederic Stupart
Chairman—J. R. Collins
Vice-Chairman—R. A. Gray, B.A.
Secretary—E. J. A. Kennedy
Treasurer—Miss Evelyn Watt
Recorder—J. R. Gibbs, F.R.M.S.
Observation Committee—Dr. C. A. Chant, J. R. Collins, A. R. Hassard, A. F. Hunter, Dr. D. B. Marsh.

OTTAWA CENTRE

President—C. C. Smith, B.A., D.L.S. *Vice-President*—J. S. Lane, B.A.
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